Air Filtering Efficiency Evaluation of PC Nanofiber Filters for Capture of Biological Particles in Personal Dosimeters

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Efficiency is one of the big challenges during the dosimeter design phase; along with cost and autonomy (power consumption). To achieve a good equilibrium between efficiency, power consumption and autonomy; the active collection filter is the key element of the dosimeter devices. This element allows optimizing pressure drop for sub-micrometer biological particles capture. The capture of the maximum particles type and their size (virus – *from 10 to 200nm-*, bacteria – *from 1 to 10 µm-* and spores –*from 0.5 to 1 µm*) is vital in the case of biological threats, where the personal dosimeter is the evidence of threat exposure and the instrument to define the correct treatment to be administrate.

The work reported has been focused at the electrospun nanofiber filter enhancement and characterization, without the use of other filtering elements such as metallic or textile foams or substrates. The use of electrospun nanofibers guarantees high elastic properties, efficiency improvement, constant pressure during filtering process, low pressure drop, and optimal management of power consumption.

The efficiency enhancement of filters manufactured by electrospinning from PC was studied at the present work and their aerosol transport properties were characterized following the main recommendations of the UNE-EN 1822-3 standard. The electrospun nanofiber filters were exposed to mono-disperse 0.1% NaCl aerosol with mono-disperse particles range of 100-200-300-400 y 500 nm. The particles permeation across the filter and the filtration efficiency given by: $P = C_{out} / C_{in}$ (eq. 1) and $E = 1- P$ (eq. 2); where *P* is the particle penetration across the filter, *E* is the filtration efficiency, C_{out} is the aerosol particle concentration upstream and C_{in} is the concentration downstream. The Quality Factor, *fc*, is given by $fc=\ln(1/P)/\Delta p = -\ln(P)/ \Delta p$ (eq. 3). These equations provide a useful measure for comparing the filtering performance of different materials.

The PC electrospun nanofiber filters were optimized by the electrospinning parameters optimization, voltage, collector needle distance, flow, viscosity, … to achieve the best material-filtering properties. The electrospun nanofiber filters were compared with a commercial filter, the glass fiber PALL filter from Millipore.

The main achievement of the work is the significant improvement of the particle filtering efficiency by the use of electrospun nanofiber filters and, in particular special porous geometrical topology. The comparison of results obtained from nanofiber filters manufactured from Material A - *D01 E01.2* and *D01 E01.3* - and Material *B* - *D01 E05.3* shows that the efficiency enhancement goal has been largely achieved. Two main challenges have been achieve with the use of electrospun nanofiber filter, the Pressure Drop has reduced by 72% and, therefore, has improved the quality factor by nearly 400 % with efficiency of all filters near the 100%. Furthermore, compared with the reference commercial filter, the PC electrospun nanofiber filter is also able to improve the quality factor by a respectable 172%.

Figures

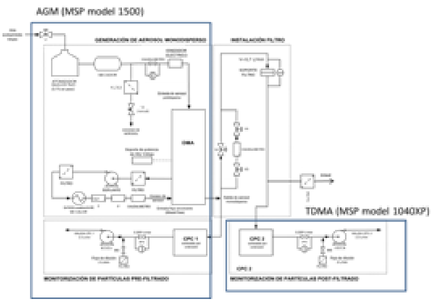

Figure 1: Experimental step-up used at the filtering test.

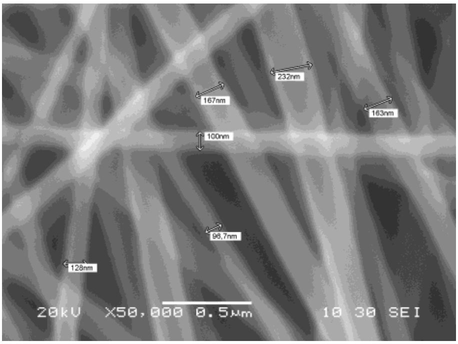

Figure 2: SEM micrograph of PC electrospun nanofibers filter

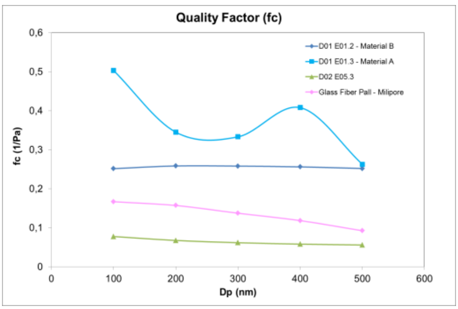

Figure 3: Quality Factor figures for the Materials A and B. Particles Penetration Speed 0,8cm/s